INDOOR AIR QUALITY ASSESSMENT

Division of Marine Fisheries
Southeast Marine Fisheries Station
50A Portside Drive
Pocasset - Bourne, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

In response to a request from a number of employees and Jim Fair, Assistant Director of the Division of Marine Fisheries (DMF), an indoor air quality assessment was conducted at DMF's Southeast Marine Fisheries Station, 50A Portside Drive in the Pocasset section of Bourne, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On October 19, 2001 a visit was made to this building by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Fair accompanied Mr. Holmes during the assessment.

The assessment was prompted by complaints of chronic ringing of the ears (tinnitis) as well as dizziness, nausea, difficulty sleeping and other symptoms over the last 1-2 years among four DMF staff members. The DMF staff are concerned over the possible role of IAQ producing these symptoms. Employees also believe their symptoms may be attributed to radio towers adjacent to this office building (see Picture 1). The building was visited by the MDPH Radiation Control (RC) program on May 16, 2001 to examine electro magnetic radiation levels and a possible relationship between the radio towers and reported symptoms. At the time of the BEHA assessment the RC report was pending.

The DMF occupies office space on the first and ground floor of a multiple occupancy building that formally served as a garage for a utilities company. The building is estimated to be approximately twenty years old. The garage was renovated into office space prior to DMF occupancy five years ago. The four employees experiencing symptoms all work for the shellfish project on the ground floor of the building along the western wall (adjacent to the radio towers) (See Picture 2). Several of the employees have undergone a number of different medical tests/exams and are being seen by eye nose and throat (ENT) specialists.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor.

Results

The DMF has a staff of 40 and is visited by approximately 5-10 members of the public daily. Tests were taken under normal operating conditions and results appear in Tables 1-4. Air samples are listed in the tables by location that the air sample was taken or last name of the occupant's workspace.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air [ppm] in seventeen of twenty-nine areas sampled throughout the building, indicating inadequate air exchange in a number of areas surveyed. An HVAC system exists in the building, consisting of two air handling units (AHUs) located in mechanical rooms on each floor. Ventilation is provided through ducted, ceiling vents (see Picture 3). Air is returned to the AHUs by wall and/or ceiling-mounted grilles through ductwork. A number of exhaust vents were obstructed by boxes, file cabinets and other items (see Picture 4) inhibiting airflow. Further limiting airflow were several louvers for return vents that were completely shut (see Picture 5).

AHUs do not appear to be ducted to the outside to provide supply or exhaust ventilation. BEHA staff could not determine if the AHUs were capable of introducing fresh air into the

system because no obvious fresh air intake vents were found. In this configuration, the AHUs only temper and recirculate air within the DMF. It appears that the building was designed to use openable windows to provide fresh air to interior spaces.

Wall-mounted thermostats control the HVAC system. The thermostat has settings of "on" and "automatic". All thermostats were set to the "automatic" setting during the assessment. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once the thermostat reaches a preset temperature, the HVAC system is deactivated until the temperature drops below the heating temperature set point. Therefore no mechanical ventilation is provided until the thermostat re-activates the system.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the

ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 70^{o} F to 76^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. Complaints of excessive cold were expressed to BEHA staff, specifically on the ground floor adjacent to the handicapped ramp, which is unheated. Several other complaints of uneven heating and cooling were also reported. The majority of occupants on the ground floor are located along the west wall, however the thermostat is located in the ground floor hallway away from occupants. In this configuration, the thermostat reads temperatures which are not representative of workspace conditions. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 36 to 45 percent, which was within or close to the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to

drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had water stained ceiling tiles, which is evidence of historic and/or current roof or plumbing leaks. An active roof leak was reported in the corner of the conservation /engineering office (see Picture 6). Office staff had reportedly contacted the landlord, who visited the building shortly after the discovery of the leak to examine roofing/flashing conditions and to identify the source of water penetration. Building staff could not verify if repairs had been made to correct the problem. Ceiling tiles can provide a source of microbial growth and should be replaced after a water leak is discovered and repaired. Water staining was also noted along the floor/lower wall of the handicapped ramp (see Picture 7).

Water infiltration and moistening of carpeting was reported in the corner of Mr. Germano's cubicle on the ground floor. BEHA staff inspected conditions along the outside perimeter of the building to identify breaches in the building envelope that may be a source of water penetration. Small trees/stumps and other plants were growing in the tarmac/exterior wall junction (see Picture 8). The growth of roots against the exterior walls, as well as spaces between the tarmac and exterior walls of the building, can bring moisture in contact with the foundation. The freezing and thawing action of water during winter months can create cracks and fissures in the foundation. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek, J. & Brennan, T., 2001). Repeated water damage to porous building materials (e.g., wallboard, ceiling tiles, carpeting) can result in microbial growth. The

American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous building materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

Other Concerns

Several other conditions that can potentially affect indoor air quality were identified. DMF staff could not confirm if the building has an HVAC preventative maintenance plan in place. BEHA staff examined the condition of filters inside the AHUs. Filters were clean and appeared to have been recently changed. However, the filter access panel in the ground floor mechanical room was not re-installed and was located several feet from the unit on the floor (see Picture 9). Also noted in the mechanical room were a used mop and a bucket in close proximity to the AHU. Mops and buckets can be sources of wet/musty odors. The breach in the AHU casing created by the lack of the filter access panel may draw air from the surrounding space into the unit. As air bypasses filters, the opportunity exists for airborne dirt, dust, odors and particulates to be distributed to occupied areas via the HVAC system. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving, and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

The mainframe room contains the computer network mainframe, laser jet printers, photocopiers and other computer and communications equipment. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Computer related equipment can also produce ozone, which is a respiratory irritant (Schmidt Etkin, D., 1992). No local exhaust ventilation is provided for this room. Without

adequate exhaust ventilation, pollutants produced by office equipment can build up and lead to poor air quality and/or comfort complaints.

Restrooms are equipped with wall-switch activated exhaust vents. These vents were operating during the assessment, however it appears that they are not ducted out of the building. BEHA staff examined conditions above ceiling tiles and found that restroom vents exhaust odors and moisture into the ceiling plenum. When occupants exit the restroom and deactivate the wall-switch, it can allow for odors and excess moisture to reenter through spaces around ceiling tiles and/or the inactive vents themselves. The exhaust vent in the ground floor restroom was observed hanging (see Picture 10). Furthermore, restroom doors are not undercut and do not have passive door vents to allow for transfer air movement into the restrooms.

In both offices and cubicle areas, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These stored items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. Dirt/dust accumulation was noted on a number of return vents (see Picture 11). The restroom exhaust vent in Picture 12 was almost completely occluded, preventing proper airflow. Vents should be cleaned periodically to ensure proper airflow and to prevent the reaerosolization of dirt, dust and particulates.

Conclusions/Recommendations

Air monitoring and observation of indoor environmental conditions by BEHA staff did not identify any indoor air quality conditions that would increase the risk of developing tinnitis among building occupants. While conditions in the building do not suggest that air quality

factors at the DMF are likely to have played a role, access to personal medical information may be helpful in order for MDPH consulting physicians to further evaluate concerns. (Note: Informed consent forms were provided to employees to facilitate this follow up activity.)

Although some occupant symptoms and complaints at the DMF are consistent with what might be expected with conditions found in the building at the time of the assessment, specific occupant complaints of tinnitis can not be readily explained by the air quality conditions seen in the building. For this reason a two-phase approach is recommended, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall concerns within the building.

In view of the findings at the time of this visit, the following **short-term** recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy independent of thermostat control. Operate building thermostats in the fan "on" position to provide constant airflow.
2. A preventative maintenance program for all HVAC equipment should be developed and implemented, which should include changing filters for AHU equipment as per the manufacturer's instructions or more frequently if needed, as well as the examination of all HVAC equipment periodically for maintenance and function.
3. After replacing filters, affix filter access.
4. Do not use mechanical rooms for storage (e.g., mops and buckets).

5. Remove all blockages from return vents and ensure return vent louvers are open to facilitate airflow.
6. Consider having the ventilation system balanced by an HVAC engineering firm.
7. Repair damaged exhaust vent in the ground floor restroom shown in Picture 10.
8. Consider placing restroom vents on a timer instead of a wall switch to provide constant exhaust during work hours.
9. Install passive vents or undercut doors for restrooms to provide adequate transfer air.
10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts. Wet wiping of flat, nonporous surfaces would also remove accumulated dust that can become aerosolized.
11. Remove plant growths against the exterior wall/foundation of the building to prevent water penetration. Examine foundation/exterior wall for breaches that can allow for water penetration and repair/seal.
12. Continue to work with landlord to report, identify and repair leaks. Replace water damaged ceiling tiles. This measure will remove actively growing mold colonies that may be present. Ceiling tiles should be removed at a time when employees are not present in the workplace. Contain the area where ceiling tiles are removed to prevent the

spread of dust and mold spores in the workplace. This practice should be conducted routinely.

13. Relocate or consider reducing the amount of materials stored in workspaces to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

14. Upon receipt of signed medical consent forms, the BEHA's environmental/occupational physician will review medical records and further evaluate health concerns.

The following **long-term** measures should be considered. Consider consulting a ventilation engineer concerning the introduction of fresh air. Have an HVAC engineer ascertain whether a fresh air intake and/or exhaust vent for the AHUs can be installed.

1. Repair and/or replace thermostats as necessary to maintain control of comfort. Consider relocating ground floor thermostat into occupied area and/or the feasibility of installing a separate thermostat to control ventilation for the laboratory.

2. Consider installing local exhaust ventilation in the main frame room.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA

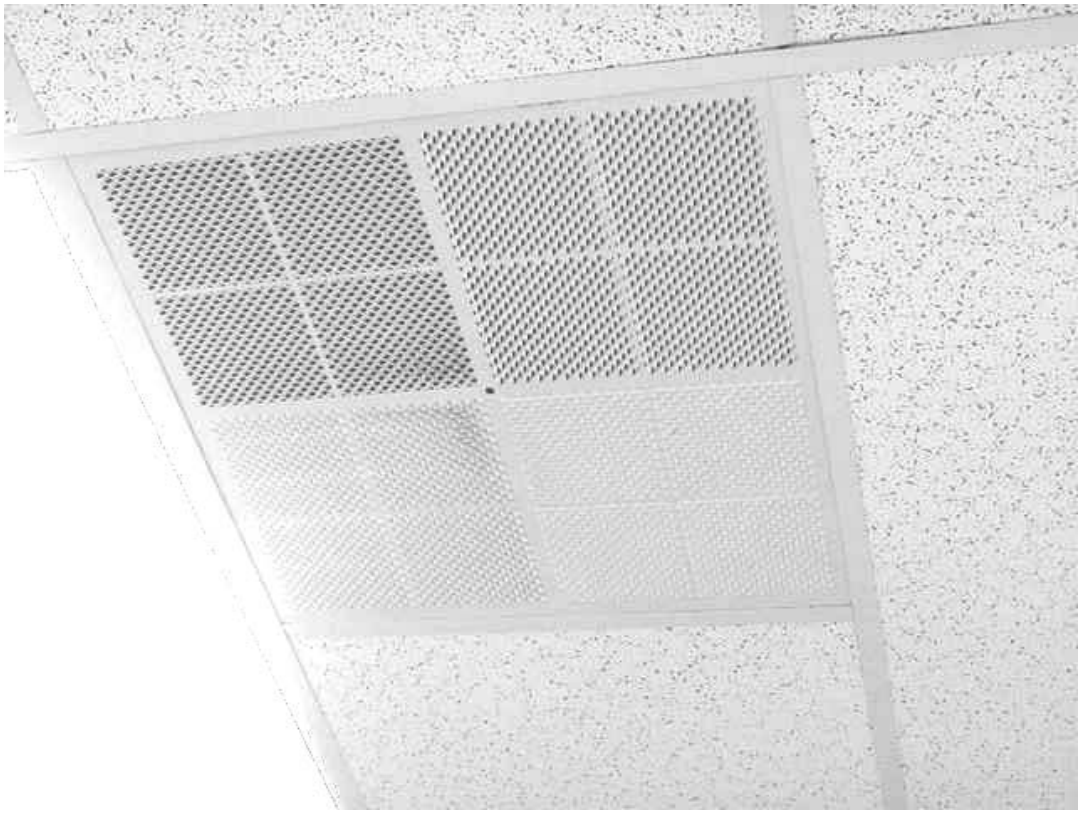
Picture 1

Radio Towers Adjacent to 50A Portside Drive

Picture 2

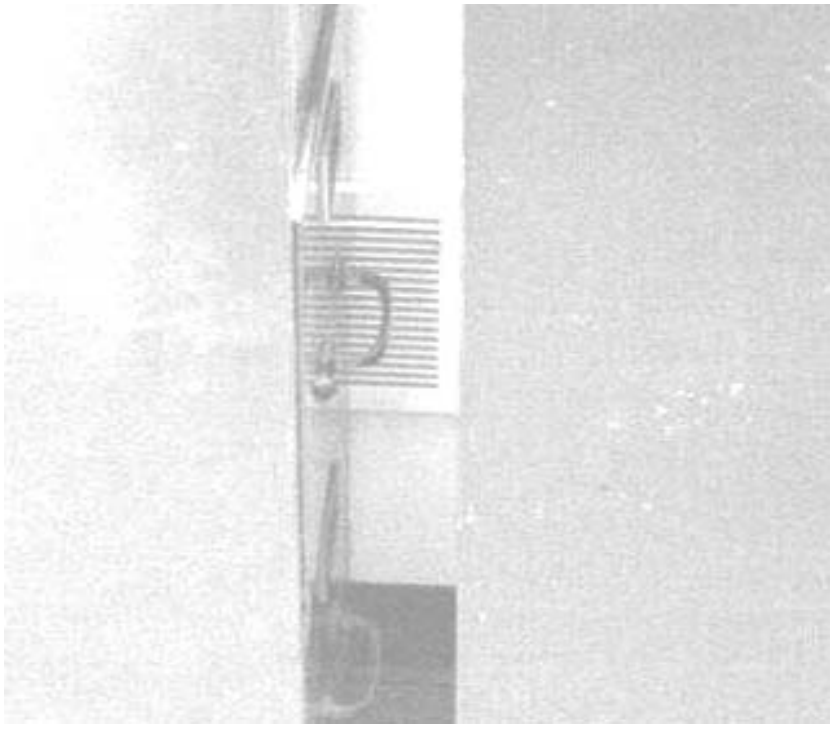
Rear View of DMF Facilities: Note Radio Tower along Southwest Wall of Building Where Employees Complaining of Symptoms Work (First Floor Windows)

Picture 3



Ceiling-Mounted Supply Vent

Picture 4



Wall-Mounted Return Vent Obstructed by File Cabinets

Picture 5

Adjustment Switch for Return Vent, Note Vent was Completely Shut Preventing Airflow

Picture 6

Water Damaged Ceiling Tile from Recent Leak in Engineering/Conservation Office

Picture 7

Water Staining along Wall/Floor Junction along Handicapped Access Ramp

Picture 8

Trees/Plants Growing between Tarmac and Foundation

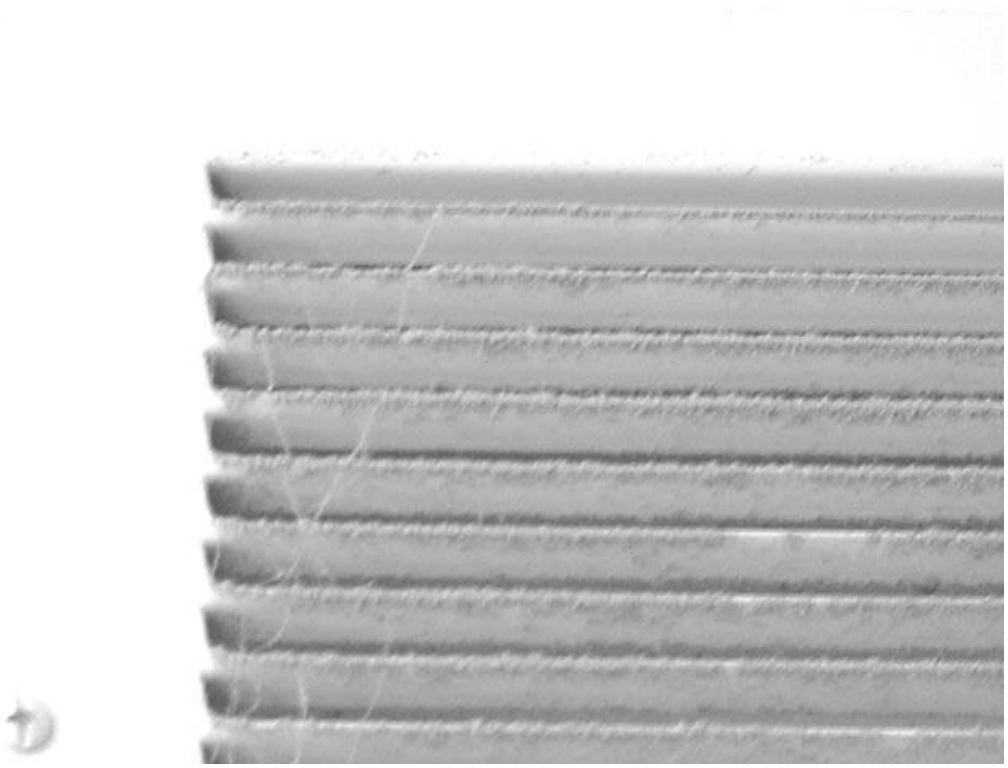
Picture 9

Ground Floor Mechanical Room

Picture 10

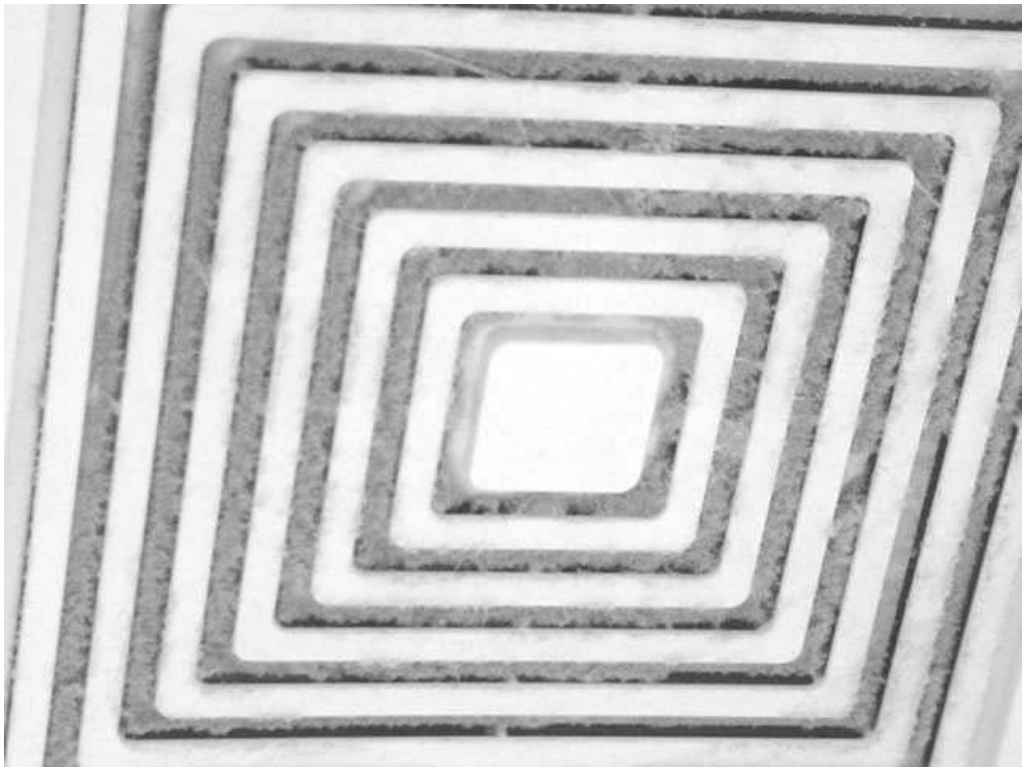
Hanging Restroom Exhaust Vent on Ground Floor

Picture 11



Return Vent Covered with Dirt, Dust and Cobwebs

Picture 12



Restroom Exhaust Vent Occluded with Dust

TABLE 1

Indoor Air Test Results – Division of Marine Fisheries, Pocasset, MA – October 19, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	367	63	42					Weather conditions: clear, sunny, slight breeze
Assistant Director's Office	1165	70	45	2	Yes	Yes	No	HVAC not operating
Hallway						No	Yes	Dirt/dust/cobweb accumulation on return vents – used as return for office space, thermostat off/fan on "auto"
Reback	1000	70	42	1	Yes	Yes	No	
Kolek	864	70	41	0	Yes	Yes	No	3 water damaged CT
Administrative Office	856	71	41	1	Yes	Yes	No	
Copy/Supply Room	559	71	40	0	No	Yes	No	Photocopier, fax
Ladies Restroom – Main Level	724	72	39	0				3 water damaged CT-reported leak/fixed, wall switch activated exhaust, door undercut/passive vent
Sport Fisheries	829	72	40	0	Yes	Yes	No	
Main Frame Room	830	74	39	0	No	Yes	No	Main frame network, laser jet printer, large photocopier, computer

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Division of Marine Fisheries, Pocasset, MA – October 19, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Germano	742	74	38	0	Yes	Yes	No	Reports of wet carpet in corner
Shellfish	721	75	38	2	Yes	Yes	Yes	Return vent closed/blocked by file cabinet, photocopier, laser printer
Whittaker	730	75	37	1	Yes	Yes	No	
Churchill	944	73	38	1	Yes	Yes	No	Window open
Chism	1016	74	39	2	No	Yes	Yes	Complaints-odor/temperature extremes
Hickey	820	75	39	1	Yes	Yes	No	Complaints-temperature extremes (cold in summer/hot in winter)
Mendes	904	76	38	2	Yes	Yes	No	4 plants
Conference Room	736	75	36	0	No	Yes	Yes	
Storage Room	747	74	38	0	No	Yes	Yes	Storage of fishery equipment, return blocked (slight odors)
Wet Lab	800	73	38	0	No	Yes	No	
Kitchen	780	74	40	0	No	Yes	No	

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TABLE 3

Indoor Air Test Results – Division of Marine Fisheries, Pocasset, MA – October 19, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Basement Restroom	780	74	39	0	No	Yes	Yes	Shower, hanging vent-not ducted
2nd Restroom	712	73	39	0	No	Yes	Yes	3 water damaged CT
Heat Pump Closet					No	No	No	Mop & bucket, filter access plate not installed-on carpet
Hallway		73						
Handicapped Access Ramp Area		73						Unheated
Lab	614	72	41	1	No	Yes	Yes	2 water damaged CT, several heat producing equipment, temperature complaints-cold/winter, HVAC functions on same thermostat as office space
Perimeter Notes								Plants in tarmac/foundation junction
Men's Restroom	846	73	39	0	No	Yes	Ys	Switch activated exhaust fan, exhaust vents not ducted-empty into ceiling plenum
Resource Assessor	1053	74	40	3	Yes	Yes	Yes	Return vent blocked by boxes

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Division of Marine Fisheries, Pocasset, MA – October 19, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Howe	1070	75	39	0	Yes	Yes	No	1 water damaged CT
Closet								Heat pump-dual filtration-supply & return, no obvious source of fresh air
Lobster	990	74	36	0	Yes	Yes	No	Heat complaints
Brady	832	75	38	0	Yes	Yes	No	1 plant
Conservation/ Engineering	1187	76	39	2	Yes	Yes		Active leak in corner, 3 water damaged CT
Power Plant	991	76	38	0	Yes	Yes	No	1 water damaged CT
Basement Hallway						No	Yes	Return vents blocked by file cabinet, thermostat off/fan "auto"

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